

## CLAIMS

1. A carbon fiber bundle comprising a plurality of single fibers, and sized with a sizing agent comprising:

5 a polymer having a main chain formed of carbon-carbon bonds, containing an acid group in at least a part of side chains or at least a part of main chain ends, and representing an acid value of 23 to 120 mgKOH/g as measured in accordance with ASTM D1386; or

10 a polymer having a main chain formed of carbon-carbon bonds, and containing at least either of an epoxy group and an ester group in at least a part of side chains or at least a part of main chain ends.

2. The carbon fiber bundle according to claim 1, wherein the sizing was conducted after pre-sized with a pre-sizing agent consisting of an epoxy resin.

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3. The carbon fiber bundle according to claim 2, wherein the sizing agent comprises at least 35 wt% of an acid modified polypropylene resin (compound a1) having a weight average molecular weight of 45,000 or less and an acid value of 23 to 120 mgKOH/g as measured in accordance with  
20 ASTM D1386.

4. The carbon fiber bundle according to claim 3, wherein the sizing agent comprises at least 5 wt% of an olefin-based thermoplastic elastomer resin (compound b).

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5. The carbon fiber bundle according to claim 4, wherein the compound b has a Vicat softening point of 120°C or less as measured in accordance with ASTM D1525-70.

5           6. The carbon fiber bundle according to any of claims 3 to 5, wherein the compound a1 has a weight average molecular weight of 20,000 or less, and an acid value of 40 to 75 mgKOH/g as measured in accordance with ASTM D1386.

10           7. The carbon fiber bundle according to claim 2, wherein the sizing agent comprises at least 40 wt% of a copolymer (compound c) obtained by copolymerizing ethylene or propylene and an epoxy-containing monomer.

15           8. The carbon fiber bundle according to any of claims 2 to 7, wherein the single fibers comprise a plurality of wrinkles on their surface, wherein a vertical difference between a highest portion and a lowest portion in a region defined by 2 μm of circumferential length × 1 μm of fiber axial direction length of the single fibers is 40 nm or more.

20           9. The carbon fiber bundle according to any of claims 2 to 8, wherein the sizing agent comprises no more than 5 wt% of a silane coupling agent having in the molecule any one of an epoxy group, a vinyl group, an amino group, a methacrylic group, an acrylic group and a straight chain alkyl group in its molecule.

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10. The carbon fiber bundle according to any of claims 2 to 9, cut to a prescribed length, wherein an amount of the sizing agent deposited to the total is 1 to 5 wt%.

5 11. The carbon fiber bundle according to claim 10, having a mass per unit length of 0.4 to 15 g/m, and a width/thickness of 3 to 10.

12. A method for producing a carbon fiber bundle comprising a plurality of single fibers, comprising the steps of:

10 pre-sizing the carbon fiber bundle with a pre-sizing agent consisting of an epoxy resin;

sizing the pre-sized carbon fiber bundle, so that an amount of a sizing agent to the total is 1 to 5 wt%, by using an aqueous sizing agent solution dissolving or dispersing in water the sizing agent comprising:

15 a polymer having a main chain formed of carbon-carbon bonds, containing an acid group in at least a part of side chains or at least a part of main chain ends, and representing an acid value of 23 to 120 mgKOH/g as measured in accordance with ASTM D1386; or

20 a polymer having a main chain formed of carbon-carbon bonds, containing at least either of an epoxy group and an ester group in at least a part of side chains or at least a part of main chain ends;

cutting the carbon fiber bundle to a prescribed length; and

drying the carbon fiber bundle cut to the prescribed length.

13. A thermoplastic resin composition comprising a thermoplastic resin and the carbon fiber bundle according to any of claims 2 to 11, wherein the carbon fiber bundle content is 3 to 60 wt%.

5 14. The thermoplastic resin composition according to claim 13, wherein the thermoplastic resin is a polyolefin-based resin.

15. A molded article obtained by molding the thermoplastic resin composition according to claim 13 or 14.

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16. The carbon fiber bundle according to claim 1, wherein the single fibers comprise a plurality of wrinkles on their surface, wherein a vertical difference between a highest portion and a lowest portion in a region defined by 2  $\mu\text{m}$  of circumferential length  $\times$  1  $\mu\text{m}$  of fiber axial direction length of the single  
15 fibers is 40 nm or more.

17. The carbon fiber bundle according to claim 16, wherein the sizing agent comprises:

20 at least 35 wt% of an acid modified polypropylene resin (compound a2) having a number average molecular weight of 45,000 or less and an acid value of 23 to 120 mgKOH/g as measured in accordance with ASTM D1386; and  
at least 5 wt% of an olefin-based thermoplastic elastomer resin (compound b).

18. The carbon fiber bundle according to claim 17, wherein the compound b has a Vicat softening point of 120°C or less as measured in accordance with ASTM D1525-70.

5            19. The carbon fiber bundle according to claim 16, wherein the sizing agent comprises at least 40 wt% of a copolymer component consisting of one or both of:

             a copolymer (compound c) obtained by copolymerizing ethylene or propylene and an epoxy-containing monomer; and

10            a copolymer (compound d) obtained by copolymerizing ethylene or propylene, an epoxy-containing monomer and an acrylic ester.

             20. The carbon fiber bundle according to claim 19, wherein the sizing agent further comprises a copolymer (compound e) obtained by copolymerizing  
15            ethylene or propylene, an acrylic ester and a monomer containing an acid anhydride group.

             21. The carbon fiber bundle according to any of claims 16 to 20, wherein cross-section of the single fiber have a ratio of major axis to minor axis  
20            of 1.03 to 1.20, and a Si content of 500 ppm or less as measured by ICP emission spectrometry.

             22. The carbon fiber bundle according to any of claims 16 to 21, wherein the sizing agent comprises no more than 5 wt% of a silane coupling  
25            agent having in the molecule any one of an epoxy group, a vinyl group, an

amino group, a methacrylic group, an acrylic group and a straight chain alkyl group.

23. The carbon fiber bundle according to any of claims 16 to 22, cut to  
5 a prescribed length, wherein an amount of the sizing agent deposited to the total is 1 to 5 wt%.

24. The carbon fiber bundle according to claim 23, having a mass per unit length of 0.4 to 15 g/m, and a width/thickness of 3 to 10.

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25. A method for producing a carbon fiber bundle comprising a plurality of single fibers, wherein the single fibers comprise a plurality of wrinkles on their surface, wherein a vertical difference between a highest portion and a lowest portion in a region defined by  $2\ \mu\text{m}$  of circumferential length  $\times$   $1\ \mu\text{m}$  of  
15 fiber axial direction length of the single fibers is 40 nm or more, comprising the steps of:

sizing the carbon fiber bundle, so that an amount of a sizing agent to the total is 1 to 5 wt%, by using an aqueous sizing agent solution dissolving or dispersing in water the sizing agent comprising:

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a polymer having a main chain formed of carbon-carbon bonds, containing an acid group in at least a part of side chains or at least a part of main chain ends, and representing an acid value of 23 to 120 mgKOH/g as measured in accordance with ASTM D1386; or

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a polymer having a main chain formed of carbon-carbon bonds, containing at least either of an epoxy group and an ester group in at least a part of side chains or at least a part of main chain ends;

cutting the carbon fiber bundle to a prescribed length with regulating the moisture content of the carbon fiber bundle to 20 to 60 wt%; and drying the carbon fiber bundle cut to a prescribed length.

5           26. A thermoplastic resin composition comprising a thermoplastic resin and the carbon fiber bundle according to any of claims 16 to 24, wherein the carbon fiber bundle content is 3 to 60 wt%.

10           27. The thermoplastic resin composition according to claim 26, wherein the thermoplastic resin is at least one selected from the group consisting of polyolefin-based resin, polycarbonate resin, ABS resin, AS resin, polyoxymethylene resin, nylon resin, polyphenylene sulfide resin, polyether sulfine resin, polyether imide resin, polyester resin and alloy-based resins thereof.

15           28. A molded article obtained by molding the thermoplastic resin composition according to claim 26 or 27.